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E83 Safety Systems

Initial Print Date: 10/03 Revision Date:

Safety Systems

Model: E83

Production: Start of Production MY 2004

OBJECTIVES

After completion of this module you will:

- Know the differences in the MRS Systems
- Understand the operation of MRS4RD
- Be able to locate all the components of MRS4RD
- Understand OC3 mat operation

History of Multiple Restraint Systems

Multiple restraint systems have a long history at BMW. The first multiple restraint system, the MRS1, was introduced as long ago as 1996.

MRS 1

With the introduction of the side airbags in March 1996, the MRS1 replaced the ZAE/BAE control unit used until then on the E38/E39. When the side airbags were introduced, two MRSA external sensors were also added for improved side-impact detection. Because of the required number of inputs/outputs, the number of pins had to be increased from 30 to 50.

MRS 2

The addition of the ITS head airbag and rear side airbags on the E38 in May 1997 saw the introduction of the MRS2. On the E39, the MRS2 was first used when the ITS head airbag was fitted in September 1997. September 1998 saw the introduction of the 2-stage front-passenger airbag (SMART airbag).

MRS 3

The MRS3 system was launched with the arrival of the 2-stage driver's airbag in March 1999. Another innovation on the MRS3 was its connection with the K-bus. The previous MRS systems had been hooked up to the diagnostic bus. The exception in that regard was the E36/7 (Z3). Since the Z3 has no K-bus, the MRS3 on the Z3 remained connected to the diagnostic bus.

MRS 4

The changes on the MRS4 as compared with the MRS3 consisted of a modified processor and new software for calculating the restraint system triggering algorithm. The MRS4 was first used in April 2001 with the launch of the MINI as well as on the E46 and E53. The E38 and E39 models were fitted with the MRS4 for the first time in August 2001.

MRS4RD

The multiple restraint system 4 redesign MRS4RD is a development of the MRS4 on the E46. The MRS4RD has had its interfaces expanded to 75 pins.

The job of the MRS4RD is to detect accident scenarios that are critical for the vehicle occupants and to selectively activate the necessary restraint systems according to the severity of the crash.

The MRS4RD has been further optimized and equipped with the following sensors:

- Up-front sensors
- Door-compression sensors
- B-pillar satellites

The job of the up-front sensors is to detect frontal impacts. This allows the restraint systems such as seatbelt tensioners and airbags to be activated.

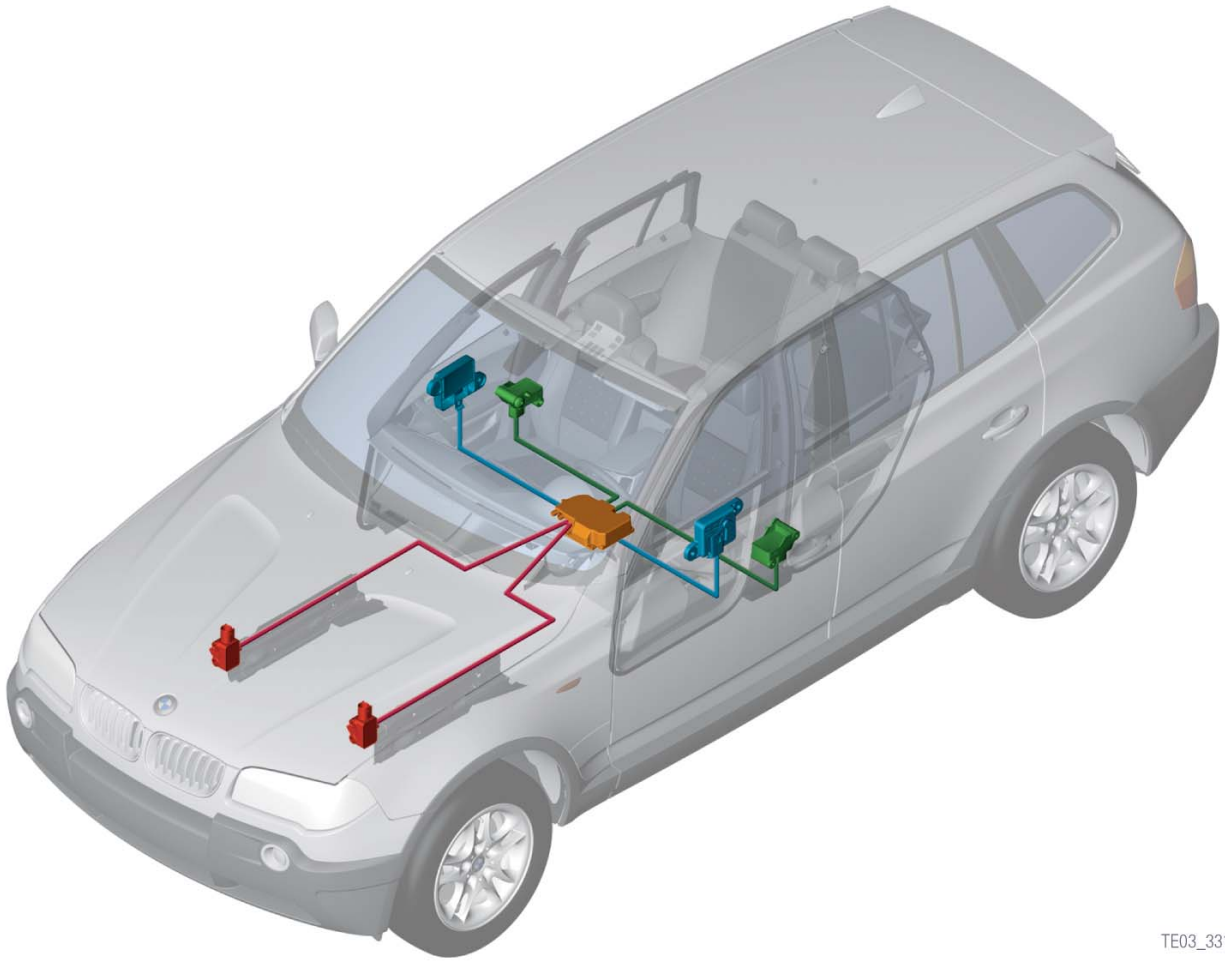
The job of the door-compression sensors is to detect side impacts The MRS4 satellites (MRSA) under the front seats have been moved to the B-pillars. The B-pillar satellites contain acceleration sensors for linear and lateral acceleration.

The MRS4RD performs a self-diagnosis and monitors all input and output signals. Any faults detected are stored in a non-volatile memory and indicated to the driver by the airbag warning lamp (AWL).

Communication with other control units in the vehicle's network of systems takes place via the K-bus.

The MRS4RD can be programmed/encoded via the K-bus.

MRS4RD Equipped E83



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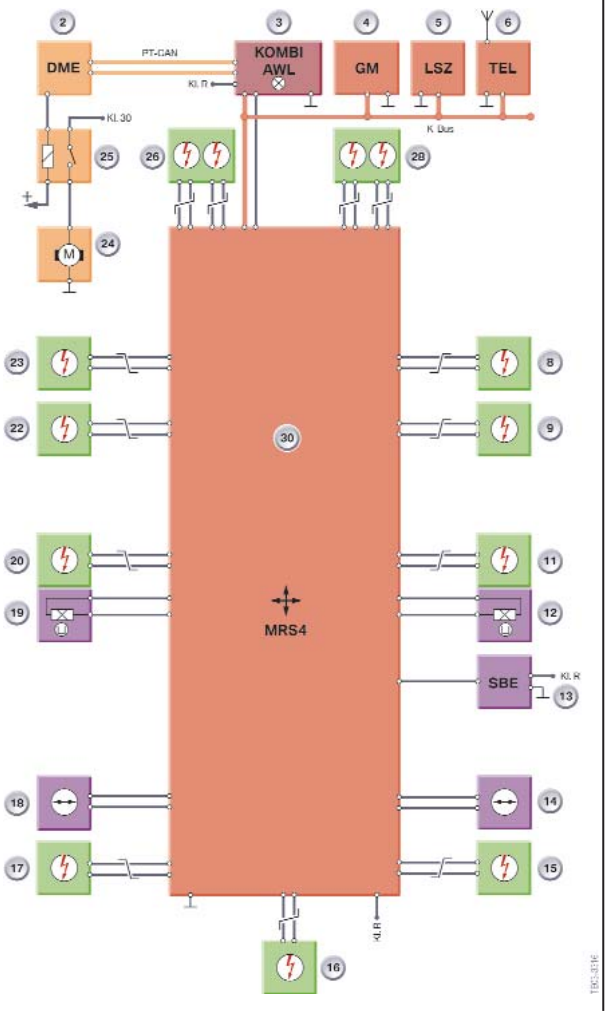
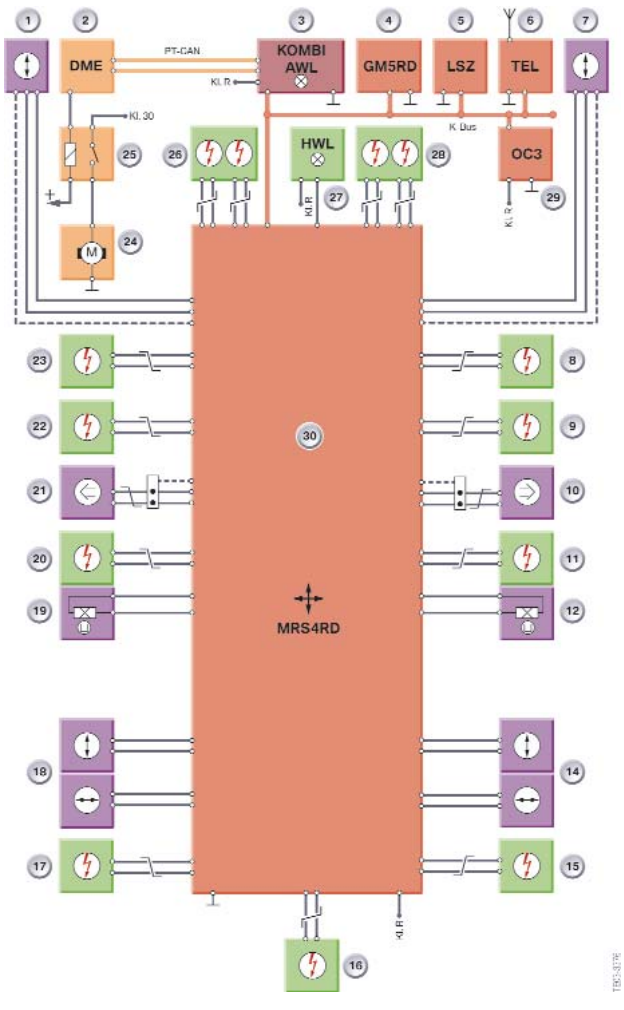
Comparison E46/E53 MRS w/ E83 MRS4RD

E46/E53



E83



1. Up-front Sensor, Left (E83)	11. Seat-belt tensioner, Right	21. Door Pressure Sensor, L (E83)
2. DME	12. Seat Belt Switch, Right	22. Side Airbag, LF
3. Instrument Cluster	13. Seat Occupation Sensor	23. ITS, Left (E83 Curtain Airbag)
4. GM5 (E83 GM5RD)	14. B-Pillar Satellite, Right (E83)	24. Electric Fuel Pump
5. LSZ	15. Side Airbag, RR	25. Fuel Pump Relay
6. Telephone	16. BST	26. Driver Airbag
7. Up-front Sensor, Right (E83)	17. Side Airbag, LR	27. Airbag Indicator Lamp (E83)
8. ITS, Right (E83 Curtain Airbag)	18. B-Pillar Satellite, Left (E83)	28. Passenger Airbag
9. Side Airbag, RF	19. Seat Belt Switch, Left	29. OC3 Mat (E83)
10. Door Pressure Sensor, R (E83)	20. Seat-belt Tensioner, Left	30. MRS Control Unit

Grayed Items X3 Only

System Components

The MRS4RD multiple restraint system consists of the following components:

- MRS4RD control unit
- Sensors and switches
- Actuators

MRS4RD Control Unit

The number of pins on the MRS4RD control unit has been increased from 50 (MRS4) to 75 because of the greater number of interfaces.

The MRS4RD control unit is located centrally in the vehicle on the transmission tunnel. Integrated in the MRS4RD control unit are two acceleration sensors set right-angles to one another. The linear acceleration sensor (X-axis) is positioned at 0 degrees to the vehicle's longitudinal axis, and the lateral acceleration sensor (Y-axis) at 90 degrees to that axis.

All acceleration sensors sense acceleration in two directions, i.e. they register both positive and negative acceleration. The polarity of the acceleration signals depends on the direction of impact. That means it is possible to distinguish between a front or rear impact and between a left or right side impact.

Sensors

The MRS4RD multiple restraint system has more sensors than its predecessor system. They include the following sensors:

- Up-front sensors
- Door-compression sensors
- B-pillar satellites with lateral and linear acceleration sensors

Up-Front Sensors

The job of the up-front sensors is to detect frontal impacts. The up-front sensors are located in the front end above the longitudinal subframe members. The up-front sensors provide the MRS control unit with the initial information on the progression and severity of the impact.

An up-front sensor consists of an acceleration sensor for detecting deceleration, a signal converter and a microprocessor for data transmission.

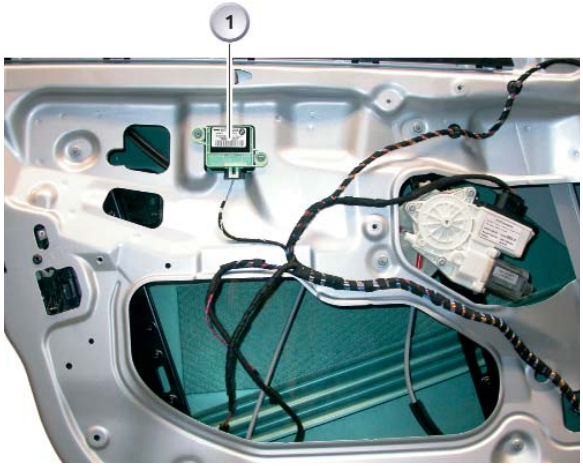
The up-front sensors are supplied with power via a current-signal interface. The up-front sensors are supplied with a current of 5 - 10 mA. When a data message is transmitted, the level jumps vertically by 20 mA.

The advantage of the current-signal interface is its constant supply of current which prevents corruption of the signal. A change of resistance in the lead does not affect the signal.

A power supply with a voltage signal would be corrupted by changes in resistance in the lead. The signal could equally be corrupted by EMC interference from other leads.

Door Pressure Sensors

The function of the door pressure sensors (1) is to provide supplementary detection of side impacts in addition to the information supplied by the lateral acceleration sensors in the B-pillar satellites and the MRS4RD control unit. The door pressure sensors are located on the inner door panel and measure the pressure inside the door.



In the event of a side impact, the outer door panel may be pushed inwards, thus compressing the space inside the door and increasing the pressure. That pressure increase is detected by the door pressure sensors. At the same time, the side impact is detected by the acceleration sensors in the B-pillar satellite. The B-pillar satellite then also transmits a data message. The MRS4RD control unit in the center of the vehicle processes the two signals and is able to trigger the restraint systems on the basis of the information provided.

B-Pillar Satellites

The two MRSA modules (multiple restraint system external satellites) which were previously positioned under the seats, have been replaced by B-pillar satellites. Each B-pillar satellite consists of a lateral acceleration sensor and a linear acceleration sensor.

As with the up-front sensors, signal transmission is cyclic. The B-pillar satellites detect side, front and rear impacts.

The left and right B-pillar satellites are identical.

Seat Occupancy Detector (OC-3 Mat)

Because of the legal situation in the USA, the presence of a child seat for a child up to one year old must be automatically detected and the passenger airbags then deactivated. The OC3 mat detects a child seat that conforms to the relevant standard (NHTSA FMVSS 208) by virtue of the pattern of the impression it makes on the seat and deactivates the passenger airbags.

A straightforward seat occupancy detector recognizes a certain weight as proof that the seat is occupied. In order to meet legislative requirements, the seat occupancy detector (SBE) has been developed into an intelligent occupant classifier (OC). This was achieved by means of the following measures:

- By a larger number of sensor elements
- By sensing a larger area of the seat
- By an intelligent electronic analyzer

OC3 Mat

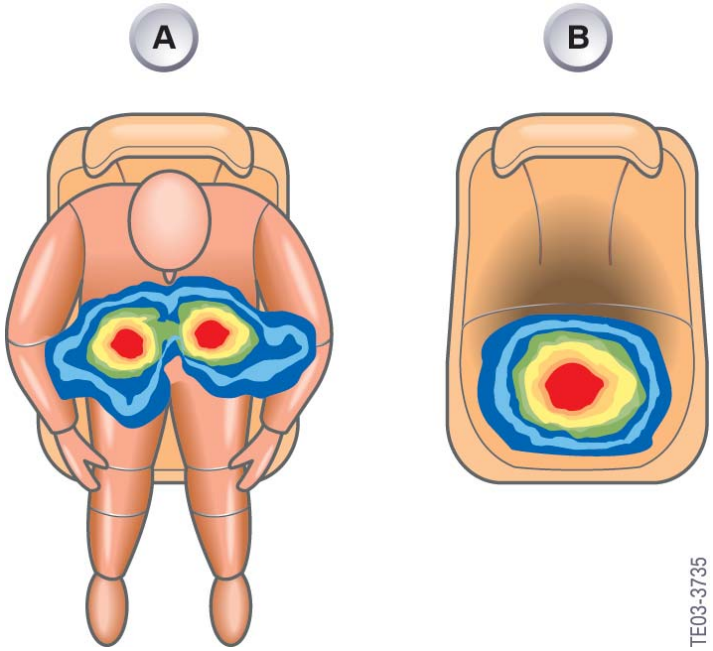
Convention Seat Occupancy Detector

The OC-3 mat is capable of distinguishing between a one-year-old child in a child's seat and a light person.

The OC-3 mat is integrated into the seat area of the passenger seat. The OC-3 mat consists of conductors with pressure-dependent resistor elements (FSR, or Force Sensitive Resistance elements). The conductors are connected to the electronic analyzer.

The FSR elements are wired in such a way that they can be sampled individually. When the mechanical load on a sensor element increases electrical resistance decreases and the measurement current changes accordingly.

By analyzing the signals from the individual sensors, the analyzer maps the occupancy of the seat surface and can identify the local concentrations of weight. The distances between the areas where pressure is applied and the concentrations of pressure reveal whether the seat is occupied by a person (A) or a child seat (B).



The analyzer of the OC3 mat sends a message to the MRS4RD control unit via the K-bus. If the system detects that the seat is unoccupied or that a child seat for a child up to one year old is fitted, the airbags on the passenger side are deactivated. The MRS4RD control unit switches on the airbag warning light. The airbag warning light indicates that the airbags on the passenger side are deactivated.

Note:
The airbag warning light is switched on if the seat is unoccupied.

Belt Buckle Switch

The belt buckle switch is used to detect whether the seatbelt has been fastened or not. The detection signal is sent to the MRS4RD control unit. The signal is used as a criterion for selective triggering of the actuators in the event of a crash. The belt buckle switch is located in the seatbelt buckle on the driver and passenger seat.

The belt buckle switch is a two-wire Hall switch. The Hall switch is supplied by the MRS4RD control unit via a current-signal interface. The current draw of the switch is the signal for the switch position. The belt buckle switch is permanently diagnosed and monitored in all electrical system statuses from Terminal R "ON" onwards.

Actuators

The Multiple Restraint System 4 Redesign is responsible for activation of the following actuators:

- Front airbag, 2-stage, driver's side
- Front airbag, 2-stage, passenger side
- Head air bag (curtain airbag), left and right
- Side airbag, front door, left and right
- Side airbag, rear door, left and right
- Seatbelt tensioner, front, left and right
- Safety battery terminal
- Airbag warning lamp

Driver's Airbag

The purpose of the driver's front airbag in conjunction with the seatbelt is to reduce the risk of serious or fatal injury to the driver in the event of a head-on collision. The front airbag for the driver's side is located in the impact pad of the steering wheel. The front airbag for the driver is equipped with a 2-stage gas generator.

Depending on the crash severity, the two stages of the airbag are ignited with a delay. The two stages of the gas generator permit the airbag to perform its restraining function in a manner appropriate to the severity of the collision, thus avoiding additional trauma to the driver during the deployment stage. The gas flowing into the airbag inflates it, and in combination with the seat belt this reduces the risk of injury in an accident.

Passenger Airbag

The purpose of the passenger front airbag in conjunction with the seatbelt is to reduce the risk of serious or fatal injury to the front passenger in the event of a head-on collision. The 2-stage passenger front airbag is located underneath the dashboard.

In a crash and depending on crash severity, the two stages of the airbag are triggered with a delay. In this way the restraining effect is matched to the severity of the crash situation. Another effect is to reduce the strain on the occupant during the airbag-deployment phase.

When the passenger airbag inflates, a hinged flap that is attached to the dashboard opens. The passenger airbag inflates towards the windscreen. The front passenger's airbag emerges upwards and supports itself on the windscreen glass and the dashboard.

Head Airbag (Curtain Airbag)

On the E83, a new head protection system, the curtain airbag, is introduced as standard equipment for the first time. It differs from the head-protection system used on the E46/E53 as follows:

- Continuous head airbag extending all the way from the A-pillar to the C-pillar

The curtain airbag extends all the way from the A-pillar to the C-pillar, covering the entire side-window area. The curtain airbag inflates between the vehicle occupants and the side windows and pillar trims. In conjunction with the side airbags in the front and rear doors, it provides optimum protection for all passengers in the event of a side on impact.

The curtain airbag reduces the risk of occupants' heads or other extremities protruding through the windows in a sideways collision. This leads to less severe neck backlash forces and less severe head injuries.

Advantages of the system:

- Extended covered area for side windows front and rear.
- Protection against glass splinters and penetrating objects.
- Optimized protective area offering protection for occupants of differing sizes.

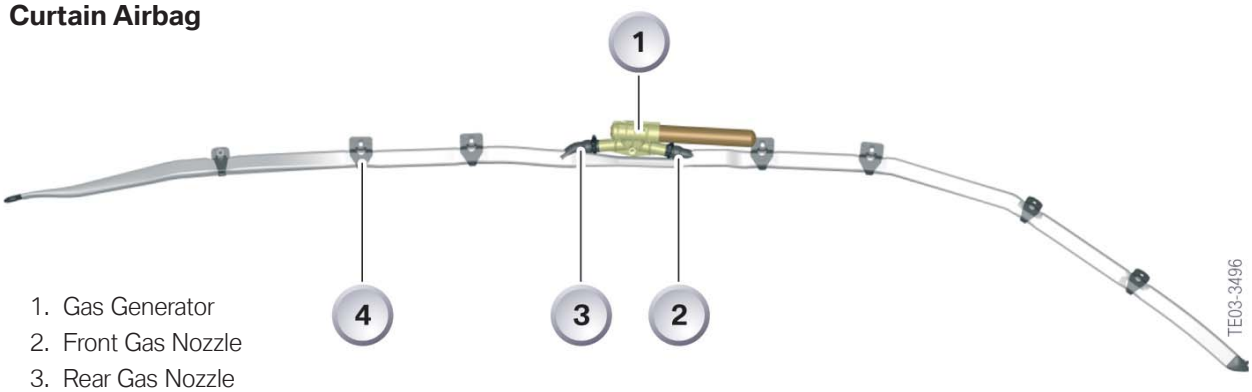
The curtain airbag is positioned along the line of roof side member, folded up. It consists of a gas generator, the two gas lances and the curtain.

In the event of a side-on collision, the generator is detonated and the gas flows through the two gas lances into the curtain. Simultaneous inflation of the curtain at the front and back achieves more even deployment.

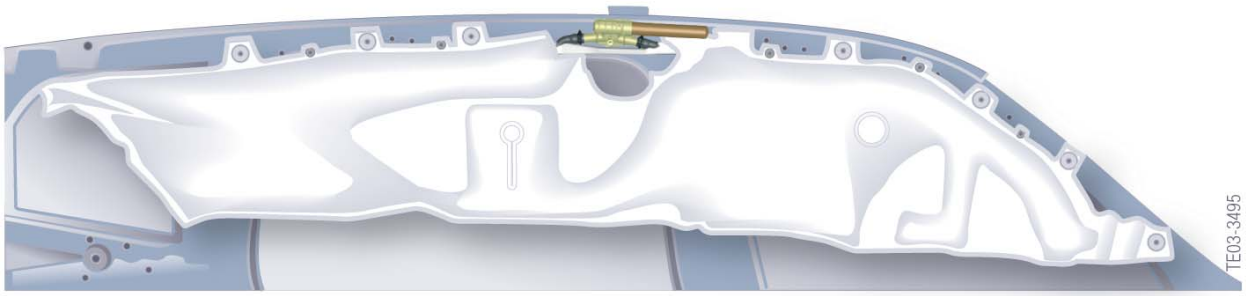
The attachment of the curtain airbag to the A-pillar and the C-pillar pulls it into position. The curtain airbag inflates between the vehicle occupants and the side windows and pillar trims.

Being a sealed system, the curtain airbag retains its shape and strength for several seconds.

Curtain Airbag



1. Gas Generator
2. Front Gas Nozzle
3. Rear Gas Nozzle
4. Airbag Retaining Clips



Side Airbag

The side airbags in the front and rear doors reduce the risk of occupant injury in the torso region of the body in the event of a side-on impact.

The side airbags are folded up inside an aluminum casing with a plastic cover behind the door trim panels. In the area of the side airbag in the door trim is a tear seam. The side airbags are fixed to the door trims as well as by a single screw to the inner door panel.

The plastic cover has defined breaking points. In a side impact of sufficient severity, the side airbag is triggered. The side airbag exits through the split line and deploys between the door and the sear occupants.

Seatbelt Tensioner

The pyrotechnic seatbelt tensioner has the task in the event of a crash to minimize any belt slack in the pelvic and shoulder region.

The seatbelt tensioner is located on the driver's and/or passenger seat. In combination with the mechanical force limiter in the inertia reel, this reduces the chest load for the seat occupants.

BST

If the MRS detects an impact of sufficient severity, the safety battery terminal is deployed. When this happens, the starter/alternator cable is electrically and mechanically disconnected. The alternator is deenergized. The safety battery terminal is located directly at the positive terminal of the battery.

System Functions

The MRS4RD control unit has to perform the following functions:

- Crash detection and calculation of deployment timing
- Activation of deployment output stages
- Documentation of time sequence of actuator deployment
- Pre-drive check
- Cyclic monitoring
- Indication of system readiness
- Indication and storage of faults
- Output of fault data (diagnosis)
- Output of crash signal for other members of the communication network
- Activation of the warning lamp if the passenger airbag is deactivated

Deployment

For the deployment output stages to be activated, the appropriate signals must be received from two different sensors, i.e. the B-pillar satellite and the MRS control-unit sensor.

In electrical-system statuses from Terminal R "ON" onwards, the MRS4RD control unit is supplied with power and is ready for operation on completion of the pre-drive check. The deployment capacitor, which acts as a power reserve, is charged to approx. 26 V via a switching regulator . The deployment capacitor provides the back-up power supply in the event of a crash in which the battery power supply is cut off.

The deployment capacitor, which provides the deployment power for the deployment output stages is controlled by a safety switch (trigger switch). The safety switch is operated by the microprocessor.

The deployment output stages consist of a high-side and a low-side power switch. The high-side power switch switches the deployment current and the low-side power switch switches the earth current. The high-side and low-side power switches are also used to check the deployment circuits as part of the pre-drive check.

The incoming sensor signals are analyzed by the analyzer module and passed on to the microprocessor. The microprocessor performs the deployment-algorithm calculations. The calculation results are compared with the event/deployment matrix and a decision reached as to the deployment of the various detonator pellets.

Pre-Drive Check

As of system status Terminal R "ON," the MRS4RD performs a pre-drive check (system test). While the pre-drive check is in progress, the airbag warning lamp is switched on for 3 - 5 seconds. Once the pre-drive check has been completed, and assuming no faults have been detected, the airbag warning lamp is switched off and the system is ready for operation.

The following tests are performed as part of the pre-drive check:

- Comparison of programmed equipment with actual equipment fitted
- Testing of deployment circuits
- Testing of resistance of deployment circuits
- Testing of internal components
- Testing of external components
- Checksum calculation for algorithm parameters

Cyclic Check

Once the pre-drive check has been successfully completed and the system is ready for operation, a cyclic check for the purposes of fault monitoring is performed. The cyclic check continues to be carried out as long as the system status is Terminal R "ON."

The following tests are performed as part of the cyclic check:

- Monitoring of resistance of deployment circuits
- Communication capability and status of components
- Power supply

System Readiness

The MRS4RD indicates that the system is ready for operation by extinguishing the airbag warning lamp (AWL).

Fault Storage

If there is a fault in the system, it is indicated by the airbag warning lamp.

If a fault occurs on the MRS4RD, it must be stored in a non-volatile memory (EEPROM). When faults are recorded, a distinction is made between internal and external faults.

If an internal fault has been detected, the record of the fault cannot be deleted, i.e. the control unit has to be replaced. The only exception in that regard is incorrect programming data.

External faults on system components are also recorded in the fault memory. Once such faults have been rectified, the record can be removed from the fault memory.

Crash Signal

In the event of a crash involving deployment of the restraint systems, the MRS4RD control unit sends a crash signal to the members of the bus network.

On receipt of that signal, the control units concerned perform the following functions according to the severity of the crash:

- Switch off electric fuel pump
- Switch off alternator
- Unlock central locking system
- Switch on hazard warning flashers
- Make emergency call (only if Professional phone option fitted)

Emergency Call (If equipped w/Telematics)

The E83 offers the customer a number of emergency call functions and a breakdown call function if the vehicle is equipped w/Telematics. The emergency call functions include a manual emergency call as well as the automatic emergency call activated as a result of a crash of appropriate severity.

Even if the vehicle is not equipped with the Motorola Everest telephone, every vehicle has a Telematic Control Unit TCU(if equipped w/Telematics), a telephone aerial, a hands-free unit as well as a GPS aerial for localization.

Manual Emergency Call

The emergency call switch (4) is connected directly to the telephone. Pressing the emergency call switch sets up a voice connection with the provider "Cross Country." The voice connection is indicated by a flashing LED in the switch.

Breakdown Call

The Breakdown call button in the Central Information Display can be activated by means of the controller. If the breakdown call button is activated, a connection to the BMW Emergency Service of the relevant country is set up.

Automatic Emergency Call

In the event of a crash of the appropriate severity, the MRS4RD control unit transmits a crash telegram to the TCU. The TCU places an emergency call, which at the same time contains the location of the vehicle.

If a navigation system is installed, the location of the vehicle is notified to the TCU. If no navigation system is installed, the location of the vehicle is determined by the internal GPS receiver of the TCU.

A voice connection is set up with the provider "Cross Country" to obtain more information on the accident (severity of the accident, number of injured) so that rescue operations can be initiated.

Workshop Exercise - Safety Systems

Vehicle is brought into shop with airbag light on.

1. *Confirm Complaint* _____
2. *Perform Short Test* _____
3. *List the Faults which pertain to the Safety System.* _____

   _____
4. *What is the next step in the diagnostics of the problem?* _____

   _____
5. *Is there a Test Plan available for this situation?* _____
6. *Does the DISplus offer any alternate diagnostic suggestions?* _____

   _____
7. *What is the result of the test suggested at the door pressure sensor?*

   _____
8. *What is the location of the MRS control module?* _____
9. *Is there an adapter that is used when testing the inputs and outputs of the MRS?* _____
10. *Perform a resistance test on the wires from the MRS to the door pressure sensor.* _____

    _____
11. *Is there an alternate connector to check this wiring?* _____

    _____
12. *Test at the alternate connector.* _____

    _____

    _____

    _____

    _____

    _____